# The Vanguard study

# The Vanguard Study: Human Performance Evaluation of UK National Organ Retrieval Service Teams Utilising a Single Scrub Practitioner in Multi-Organ Retrieval

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## Authorship Page

Authorship statements per author:

Morozova, Martindale, Richards, Stirling and Currie participated in research design. Morozova, Martindale, Richards and Currie participated in the writing of the article. Morozova, McIntyre and Stirling carried out data collection. McIntyre and Stirling facilitated communications with NORS teams at all stages of research. Morozova under supervision of Martindale and Richards carried out data analysis.

Disclosure:

Gala Morozova, Amanda Matrindale and Hugh Richards have no conflict of interest to declare. Ian Currie has been paid honoraria for educational lectures in transplantation by Sandoz and Chiesi. In mid 2019 Ian Currie was appointed to the post of UK Clinical Lead for Organ Retrieval with NHS Blood and Transplant. Cecelia McIntyre is a Retrieval & Transplant Project Lead Specialist at NHS Blood and Transplant. John Stirling is a NORS Workforce Transformation Program Lead at NHS Blood and Transplant.

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## Abbreviations Page

All acronyms – listed alphabetically (e.g.)

AB, Abdominal organ retrieval team

CT, Cardiothoracic organ retrieval team

DBD, Donation following Brainstem Death

DCD, Donation following Circulatory Death

NHSBT, NHS Blood and Transplant

NORS, National Organ Retrieval Service

S, Standard configuration

SNOD, Specialist Nurse Organ Donation

SURG-TLX, Surgery Task Load Index

TEAM, Team Emergency Assessment Measure

V, Vanguard configuration

**Abstract (248 words)**

**Background:** The National Organ Retrieval Service (NORS) 2015 review recommended a single scrub practitioner provide support simultaneously to abdominal and cardiothoracic teams in UK multi-organ retrieval. Previously, this model had been employed only by the combined abdominal and cardiac team in Scotland. This study reports the impact on performance as part of the Vanguard project, which utilised the single scrub practitioner role with five NORS teams, to determine applicability UK-wide.

**Methods:** Participants comprised members of abdominal (n=56) and cardiothoracic (n=54) teams attending UK thoraco-abdominal retrievals. Data were collected by validated psychometric scales to assess individual workload, anxiety, confidence, demands/coping resources, and teamwork. Additional data were collected through open comments and quantitative data describing context and outcome of retrieval.

**Results:** Abdominal and Cardiothoracic teams showed different responses when using single (Vanguard) or dual scrub practitioners (Standard) . Vanguard configuration was associated with significantly higher anxiety for abdominal but not cardiothoracic teams. Perceived workload increased for abdominal teams during Vanguard but decreased for cardiothoracic teams. Scrub practitioners reported elevated anxiety and decreased confidence in retrievals using Vanguard configuration.

**Conclusions:** This is the first large study examining human performance during organ retrieval in the UK. Despite previous regional success, this study showed a significant negative impact of the single scrub practitioner when extrapolated widely to UK teams. As a result of this study, NORS declined to implement the single scrub model. These data support the use of human performance analysis as an essential part of successful development in organ retrieval practice.

## Introduction

The UK National Organ Retrieval Service (NORS), introduced in 2010, undertakes all commissioned cardiothoracic and abdominal organ retrieval including heart, lung, liver, kidney and pancreas. The service comprises 10 abdominal and 6 cardiothoracic teams, based in transplant units across the UK. Prior to the advent of NORS, a combined cardiothoracic and abdominal team with a single scrub practitioner supporting both teams had operated in Scotland for many years. All other UK teams operated independently with their own scrub practitioners.

In response to the rapid increase in organ donation across the UK and unprecedented peak demands on staffing, NHS Blood and Transplant (NHSBT) undertook the NORS review in 2015[1]. A key recommendation to improve effectiveness and efficiency was to reconfigure all UK teams to feature a Single Scrub Practitioner to assist both abdominal and cardiothoracic teams during multi-organ retrieval. Partly, this was to recapitulate the nominally successful approach of the pre-existing combined team, and in part to support staff development in additional retrieval roles.

Although the single scrub model had been safely utilised in Donation following Brainstem Death (DBD) retrievals by the combined abdominal and cardiothoracic team in Scotland, it had never been tested in Donation after Circulatory Death (DCD) retrievals. DCD surgery is conducted at a much higher speed than DBD retrievals, and DCD organs are associated with

greater risks of graft failure and complications during both retrieval and transplantation[2,3]. There was concern that the single scrub model could lead to a deterioration in surgical performance. However, of greater concern was feasibility of the reconfiguration in relation to workload, the impact of additional pressure for scrub practitioners, and the longer-term impact recruitment and retention. Retrieval scrub practitioners are well recognised as highly trained and resilient individuals. However, the implementation of the single scrub role could trigger departure in favour of more manageable and balanced employment in other roles. In order to address this serious concern, it was necessary to assess organ retrieval staff using advanced psychometric testing, in the standard and single scrub practitioner configurations.

Despite the importance of human performance in surgical procedures, no previous research has been published on enhancing individual and team performance in organ retrieval[3]. Retrievals may place staff in emotionally challenging situations beyond normal role expectation, particularly in paediatric donation. Additionally, staff are subject to the physical rigours of sleep deprivation, prolonged working time and operating in unfamiliar donor hospitals with unfamiliar colleagues. Nonetheless, during multi-organ retrievals, cardiothoracic and abdominal teams must cooperate effectively, coordinating with precision to retrieve organs which are safe to transplant.

Despite the critical contribution of the whole team to operative success, the great majority of the literature has focused on individual medical staff[4,5]. Surgeons report a wide range of intraoperative stressors[6] including but not limited to emergencies, complications, distractions, advanced tasks (e.g.,

high-risk patients, time pressure), that can lead to high levels of stress and intense workload especially if multiple stressors are present simultaneously. Stress has been shown to impair surgeons' psychomotor performance, technical and non-technical skills, and lead to an increase in the incidence of errors[5,7,8]. Although the body of literature on stress in surgery is substantial[5,6,9], there is very little known on the sources and impact of stress on the rest of the operating team, and no information specific to organ retrieval.

Poor teamwork and communication deficiencies have been identified as major contributing factor in every fourth medical malpractice review[10]. Although individual expertise is important, effective teamwork is essential to co-ordinate the efforts of a set of highly skilled individuals to form an expert team[11]. Moreover, in order to perform at a high level, teams must have the ability to adapt to novel, uncertain and changing demands of the environment whilst maintaining effective coordination with each other[12].

The importance of non-technical skills across the surgical domains is well recognised, however there is a lack of focus on non-technical elements in surgical training and assessment[13,14]. Patient outcome measures provide little or no insight into why some teams outperform others or how changes to team performance can be achieved through training. In determining effective human performance, a focuss on processes (such as adhering to preparatory checklists[15]) or psychological variables (such as self-confidence or anxiety[16]) has been shown as most relevant to maintaining standards for two reasons. Firstly, global outcomes can be influenced by a myriad of factors which can only be ascertained through individual case analysis, and secondly

understanding the role of factors that occur immediately prior to performance enable practitioners to know how to respond and adapt effectively. Investigating the mechanisms underpinning individual and team performance in organ retrieval can contribute to training and help better prepare NORS staff to meet increasing demands.

To understand the impact of proposed changes to organ retrieval team structure on NORS staff performance, we determined to explore role-specific (e.g., Surgeons, Scrub Practitioners) and team-specific (Abdominal vs Cardiothoracic) differences in perceived workload, stress and teamwork in teams using a single Scrub Practitioner (Vanguard) and dual Scrub Practitioners (Standard). To achieve this, we utilised a range of validated psychological measures in real-time organ retrieval settings.

## Materials and Methods

### Study Design

A naturalistic, longitudinal between-groups design compared retrievals using a single Scrub Practitioner assisting both Abdominal and Cardiothoracic teams (referred to as “Vanguard”) with those using separate Scrub Practitioner, (referred to as “Standard”). The naturalistic design meant conditions were not manipulated by the research team. General characteristics of each retrieval event are documented by NHSBT which facilitated comparisons between different retrieval types. The University of Edinburgh’s Moray House School of Education Ethics Committee granted ethical approval for this study and the study was registered with the Quality

Improvement Team at NHS Lothian. NHSBT established the Vanguard Project Board to ensure oversight, governance and donor safety for the project.

**Participants**

Purposive sampling was utilised to represent different types of UK retrieval teams, which could not be assured with randomisation. Teams were selected through discussion of 3 experienced staff limiting any individual bias. Five NORS teams, including two out of six UK cardiothoracic (CT) and three out of ten UK abdominal (AB), were identified based on geographical proximity to one another (more likely to go out on a multi-organ retrieval together), geographical distribution across the UK (two teams from South, two teams from North, and one team from Scotland), and retrieval workload. The teams selected were Papworth and Newcastle CT teams and Edinburgh, Newcastle and Addenbrookes AB teams. The study included all selected abdominal and cardiothoracic surgical teams, attending multi-organ retrievals in the UK from May to December 2017. NORS Team Leads, having agreed to participate, assisted with the recruitment of lead surgeons, surgical assistants and scrub practitioners. Other members of the teams (e.g., perfusion practitioners, transplant practitioners) also had the opportunity to take part in the study should they wish but were not specifically targeted for recruitment. To preserve anonymity and comply with ethical approval, respondents did not identify themselves apart from professional role.

## Measures

Following a simulated event[17], the research team, in collaboration with the NHSBT Vanguard project board, designed the study documentation for use when one of the participating teams attended a multi-organ retrieval. Four psychometrically validated scales previously used in research in high performance contexts, were selected on the basis of short completion time, reducing respondent demand and increasing potential completion rates.

**Demand and Resource Evaluation.** A 6-point Likert scale anchored between *not at all* (1) and *extremely* (6) was used to assess two items: "How demanding do you expect the upcoming retrieval to be?" (Demand) and "How able are you to cope with the demands of the upcoming retrieval?" (Resource). The single score was then calculated by subtracting demands from resources[18]. Positive scores reflected a challenge state and negative score reflected a threat state.

**Anxiety and confidence.** Mental Readiness scale[19] assessed individual perceptions of cognitive anxiety, somatic anxiety, and self-confidence. To assess cognitive and somatic anxiety, verbal anchors 'worried – not worried', 'tense – not tense' were used. To increase the precision of the third item, confidence was separated to reflect self-confidence (using verbal anchors: 'confident in myself – not confident in myself') and confidence in team, ('confident in team – not confident in team'). This reflects a well-established distinction in these two elements particularly relevant to team

performance situations (e.g. self and collective efficacy[20]). All items were scored on an 11-point scale.

**Surgery Task Load.** Perceived workload was measured using the Surgery Task Load Index (SURG-TLX[21]). Participants rated intensity of six factors (mental, physical, and temporal demands, complexity of the task, situational stress, and distractions) to provide a comprehensive subjective measure of workload. Each factor was rated on a 20-point scale (High to Low). The SURG-TLX is a validated adaptation of the well-established workload measure National Aeronautics and Space Administration – Task Load Index (NASA-TLX[22]) and has been developed for use in surgical domains[21].

**Team performance**. Eleven dimensions of team performance (rated 0 to 6) and one rating of global team performance (rated 1 to 10) were made by observers to rate teamwork (Team Emergency Assessment Measure; TEAM[23]).

## Data Collection

Prior to data collection, the Informed Consent Form and Information Sheet were sent to all participating teams. Participants then received an e-pack that included data collection forms and instructions. Each team had a nominated coordinator who collated and submitted data for their team.

Routine retrieval data were also collected by NHSBT, including: Donation date and Donor type (DCD or DBD); teams attending the retrieval by name, location and speciality; travel time to the location of the retrieval (mins)

for each team; time of access to theatre; operation start and end time; team departure time; perfusion start times; organs retrieved and subsequently transplanted; and reasons if one or both teams stood down. These data allowed checks on retrievals for normality and representativeness to wider NORS service.

## Procedure

**Data collection procedure.** Data were collected immediately before and after real-life multi-organ retrievals. Data included: (1) self-report ratings on psychometric scales, (2) free text comments, and (3) routine quantitative data (e.g., duration, travel time). Data collection forms were approved by NHSBT board and piloted prior to use. Figure 1 illustrates the order of events and was provided as visual aid for the teams.

Insert Figure 1 here

Prior to retrieval participants completed Resource/Demand evaluations[24] and the Mental Readiness Form[19]. Immediately after each retrieval, participants reported perceived workload[21] and gave a global rating to overall team performance. Observers (SNOD or other member of donor hospital staff) rated teamwork and team performance[23] after procedure. All participants and observers were prompted to offer additional (open) comments.

In addition to psychological measures, participants were asked to provide information about the retrieval and their role so the pre and post forms could later be paired and matched with NHSBT data. These details included: Date, ODT number (unique number assigned to each donor by NHSBT);

Team configuration (Standard or Vanguard); Procedure (DBD or DCD); Team (Abdominal or Cardiothoracic); and their professional role (Lead Surgeon, Surgical Assistant, Scrub Practitioner, or Other).

**Data analysis.** Data were merged using the statistical software package STATA[25] in two ways; by team for team level analysis (e.g., Abdominal, Cardiothoracic) and by role for individual level analysis (e.g., Lead Surgeon, Scrub Practitioner). As all team members play a crucial part in organ retrieval process the team level of analysis was used to explore the effects of proposed changes on teams as a whole. A role-based analysis was used to determine whether the changes affected some members differently. After the datasets were merged Statistical Package for the Social Sciences[26] software was used for analysis, where comparisons were drawn using unpaired samples T-test. Significance was set at $p<0.05$.

## Results

### Study Sample

During the seven-month data collection period 336 multi-organ retrievals were undertaken in the UK of which 186 (55%) were attended by at least one of the participating teams. Data were collected on 95 multi-organ retrievals, which represents 51% of all multi-organ retrievals attended by the participating teams. The team members indicated that the Shared Scrub Practitioner was attempted before the procedure had started in 24% of vanguard opportunities (n=12). Observers reported at the end of the procedure that the Shared Scrub was utilised on 9 occasions, 27% of all

opportunities available to use Vanguard configuration. See Supplementary Document Materials & Methods for more detail.

**Vanguard vs Standard Comparison Results**

**Demand and resource evaluation** showed no significant difference between Vanguard and Standard conditions in how AB teams evaluated the demands of an operation and their ability to cope with it (see Table 1). CT teams evaluated their ability to cope with the demands of Standard retrieval (*M*=4.91, *SD*=0.85) significantly higher (p=0.01) than in Vanguard configuration (*M*=3.88, *SD*=1.17). There was no statistically significant difference in the Challenge and Threat states between Standard and Vanguard configurations for AB and CT teams. In both conditions, on average, teams were more challenged (positive score) than threatened (negative score), with the lowest average score demonstrated by AB teams *(M*=0.29, *SD*=1.20) in Vanguard configuration.

Insert Table 1 here

There was no significant difference in demand and resource evaluation for any role when analysis was carried out on individual level.

**Reported anxiety and confidence.** Cognitive anxiety and somatic anxiety levels were significantly higher (*p=0.036* and *p=0.021* respectively) in Vanguard (n=8) configuration in comparison with Standard (n=48) for AB teams (see Figure 2).

Insert Figure 2 here

There was no significant difference in anxiety and confidence between Standard (n=48) and Vanguard (n=6) conditions on a team level for CT teams (see Supplementary Document Results Table A).

When compared on individual, rather than team level, Lead Surgeons showed significantly higher self-confidence ($p<0.05$) in Vanguard compared to Standard configuration. Scrub Practitioners demonstrated significantly higher levels of both cognitive ($p<0.01$) and somatic ($p<0.01$) anxiety and lower confidence in both self ($p<0.05$) and team ($p<0.05$), in Vanguard configuration compared to Standard (see Table 2). There was no significant difference between conditions for Surgical Assistants and other members of retrieval teams (see Supplementary Document Results Table B).

Insert Table 2 here

**Task workload.** AB teams reported Temporal Demands (p=0.018); Task Complexity (p=0.001); and Situational Stress (p=0.003) as significantly higher in Vanguard condition (n=8) in comparison with Standard (n=46). In contrast, for CT teams Physical demands (p=0.002); Temporal demands (p=0.012); Distractions (p=0.025) were significantly lower in Vanguard condition in comparison with Standard. However, it should be noted that the sample size for CT teams in Vanguard condition was comprised of only 5 occasions. Figure 3 illustrates the direction of change in perceived workload from Standard to Vanguard configuration for both AB and CT teams.

Insert Figure 3 here

There were no statistically significant differences across team roles in perceived workload in Vanguard compared to Standard conditions (see Supplementary Document Results Table C).

**Team performance.** Out of the 11 items on the TEAM scale, only team communication was rated by the observers as significantly higher (p=0.015) in Vanguard (M=5.93; n=5) in comparison with Standard (M=5.63; n=50) configuration. There was no significant difference in the way teams or observers rated the overall team performance after the retrieval in Vanguard and Standard condition (see Supplementary Document Results Table D). There was no significant difference in overall team performance ratings for any role when analysis was carried out on individual level.

**Open comments.** Data collected via free-form comments showed that organ retrieval staff considered the cold phase and cross clamp to be the pressure points of the retrievals in Vanguard configuration. Staff also identified practical challenges such as longer set up time, and space constraints; and procedural challenges related to unfamiliar equipment and issues with instrument count (see Table 3).

Insert Table 3 and 4 here

The competing demands on the shared scrub practitioner, and differences in expectations from AB and CT teams on what the shared scrub role entails, were the most commonly reported sources of stress for staff in Vanguard retrievals (see Table 4). See Supplementary Document Results Table E for full analysis of the open comments.

## Team Role and Procedure Comparison Results

**Lead surgeon vs scrub practitioner.** Scrub Practitioners (n=98) as a group, regardless of team configuration (Standard or Vanguard) or team specialisation (AB or CT), rated the demands (p=0.045) of upcoming retrievals and the resources (p=0.040) available to them to cope with these demands significantly higher in comparison with Lead Surgeons (n=74). They have also reported significantly higher cognitive anxiety levels (p=0.019) and rated all components of the perceived workload scale significantly higher ($p<0.05$) compared to Lead Surgeons (see Table 5).

Insert Table 5 here

**DBD vs DCD.** The results of perceived workload analysis indicated that Scrub Practitioners rated the temporal demands of DCD retrievals (M=13.20, SD=3.91) significantly higher (p=0.028) in comparison with DBD retrievals (M=9.75, SD=6.07). Surgical Assistants by contrast, reported significantly higher (p=0.045) Physical demands in DBD retrievals (M=8.80, SD=5.67) in comparison with DCD (M=5.14, SD=3.67). There were no statistically significant differences in demand resource evaluation, perceived anxiety and confidence, or teamwork between DCD and DBD retrievals when compared by role or by team (see Supplementary Document Results Table F).

## Discussion

Multi-organ retrieval surgery is highly demanding and the consequences of impaired performance can be devastating for the organ recipients.

However, factors relevant to effective individual and team performance have been under-researched. To determine the potential impact of changing from combined cardiothoracic and abdominal retrievals featuring a scrub practitioner for each team (Standard) to a single scrub practitioner supporting both teams (Vanguard), this study gathered data from abdominal and cardiothoracic teams in both configurations. Data showed complex and role-specific impacts providing new and unexpected insights into individual and team performance. Findings supported the decision not to introduce the single scrub practitioner model in the UK at this time.

The relatively small number of Vanguard cases within the data indicates teams did not use Vanguard configuration at every opportunity, suggesting reluctance to try out the new configuration. Free text comments indicate this may be linked to lack of training. In addition this may also be caused by uncertainty and lack of confidence, often associated with change and disruption to normal practice[27]. Higher cognitive and somatic anxiety levels, specifically in abdominal team members generally, and particularly scrub practitioners, during Vanguard retrievals is consistent with greater task uncertainty.

Abdominal and Cardiothoracic teams showed different responses to Vanguard configuration. The higher cognitive and somatic anxiety for Abdominal but not Cardiothoracic teams is likely because in Vanguard the Scrub Practitioner from the abdominal team was expected to perform the new Shared Scrub role. Therefore, the abdominal teams had additional responsibilities during multi-organ retrievals. Consistent with this

interpretation, abdominal teams reported increased task workload during Vanguard, but workload decreased for cardiothoracic teams. Moreover, scrub practitioners, who experienced the biggest role-shift, reported elevated anxiety and decreased confidence in retrievals using Vanguard configuration.

Results showed no significant change in individual appraisals of ‘threat’ or ‘challenge’. Thus, despite elevated anxiety and decreased confidence for Abdominal teams in Vanguard configuration, staff still felt that their resources (e.g. skills, training) were sufficient to meet the demands of the task. Notably, however, CT teams evaluated their ability to deal with the Vanguard configuration significantly lower than with the Standard configuration.

An important contribution of this study is assessing psychological variables across roles and conditions, irrespective of surgical team (AB or CT). Scrub practitioners rated the demands of retrieval as significantly higher than Lead Surgeons, and also reported higher anxiety and workload levels. Although Lead Surgeons carry responsibility for the conduct of the operation and for supporting the team, the fact they report lower levels of stress may logically be explained by greater perceived control over operative procedures.

A critically important finding was the difference in the scrub practitioners’ psychological experience of organ retrieval surgery. Traditionally research on operative success has focussed on the surgeons, along with the supporting team. This study recognises the critical importance of each team member for effective team performance. Individual assessment has shown that scrub practitioners and surgeons have quite different loading during retrieval surgery. In the future changes to structures and roles within a surgical team,

should be addressed with training that corresponds to the novel technical and psychological demands. In particular, this study investigated differences between DBD and DCD retrievals, as the Vanguard model had never been tested in DCD. DCD was perceived to have significantly higher temporal demand compared to DBD by scrub practitioners. However, the data did not show global differences at the team level.

Comparison of perceived workload suggests that that to improve performance in Vanguard configuration Abdominal teams should have specific support to address the higher temporal demands, task complexity, and situational stress.

Finally, data from teamwork and the team performance assessment have indicated a ceiling effect in data, suggesting that the extension to response format did not solve previously encountered issues with application of TEAM in organ retrieval. This highlights the need for a suitable organ retrieval specific team performance measure.

**Key Limitations**

Limitations of this study must be considered when interpreting results. Firstly, although data collection forms were designed for easy completion, the self-administration procedure adopted means there was little control over how or whether these forms were completed. This was addressed partially by each centre having a local team member supporting form completion, and team members became more familiar with data collection over the study period. Despite limitations, this procedure ensured that participation was voluntary and facilitated collecting of a large quantity of data.

Secondly, the number of Vanguard retrievals is a concern to the external validity, since the small sample size of Vanguard cases captured in the dataset might not be representative. Furthermore, it is equally possible that the novelty of the procedure and attitudes towards this change might account for the difference rather than the configuration itself. However, it is important to note that the data were collected over a 7-month period and the introduction of the Single Scrub role for the participating teams was managed by NHSBT. Therefore, it is unlikely that the introduction of this change to wider NORS would be organised or be perceived differently by other teams. Smaller studies have increased risk of type 2 error, or the failure to detect differences when they are present. However, in this study data repeatedly yielded significant differences, giving new insights to important psychological processes in retrieval teams. Data collected in situ, rather than in laboratory or simulated conditions, greatly increase ecological validity and provides valuable information on human performance in real-life organ retrieval teams.

Finally, the study is limited by focussing solely on UK teams implementing a Single Scrub team model and may not generalise directly to different organisations, contexts and cultures. However, there is no published data equivalent in approach that would enable comparisons to be made. Due to lack of research on team performance in organ retrieval we do not know whether a similar pressure point might exist in countries currently using Single Scrub model. The systematic approach to measurement and design, demonstrated in this study and focussing on human performance of individuals and teams provides a model which can be applied to other

improvement and implementation efforts across surgical disciplines, healthcare systems and organisations.

**Conclusions**

This is the first large-scale study examining human performance factors in organ retrieval in the UK[3]. The results of the study have already generated impact for the organ retrieval community as NHSBT has decided to suspend the introduction of the Vanguard team model across the UK based on these findings. This highlights the importance of human performance evaluation in assessing the impact of change to support successful organ retrieval practice and has demonstrated the value that such research can bring to policymakers and practitioners.

The study also has demonstrated a number of avenues for further research in retrieval surgery including the use of SURG-TLX[21] workload measure to tailor organ retrieval training according to specific needs of different specialities within a team. Furthermore, the use of psychometric measures and performance psychology research to assess individual and team responses, and enhance implementation efforts in organ retrieval can be developed. Future research should investigate the relationship between organ retrieval team performance and proxy markers used as indicators of organ quality and patient outcomes to establish clinical impact of team performance.

The key implication of the findings is that providing support to lower anxiety, build confidence and adjust attitudes towards changes, of organ retrieval staff would be beneficial for successful implementation of a new team configuration. All of the above can be achieved through training, which

highlights once again that training in surgery must aim towards inclusion of non-technical elements as well as the technical elements of future innovations.

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## Tables

*Table 1 Demand and Resource Evaluation – Comparison between Standard and Vanguard conditions for Abdominal and Cardiothoracic teams, Unpaired samples T-test results*

| | **Abdominal Teams** | | **Cardiothoracic teams** | |
|---|---|---|---|---|
| | Standard (n=48) M (SD) | Vanguard (n=8) M (SD) | Standard (n=48) M (SD) | Vanguard (n=6) M (SD) |
| Challenge vs Threat | 1.23 (1.38) | 0.29 (1.20) | 1.39 (0.24) | 1.03 (0.82) |
| **"How demanding** do you expect the upcoming retrieval to be" | 3.08 (1.02) | 3.60 (1.49) | 3.53 (1.52) | 2.68 (1.00) |
| **"How able** are you **to cope** with the demands of upcoming retrieval" | 4.31 (0.98) | 3.90 (1.37) | 4.91** (0.85) | 3.88** (1.17) |

** *p = 0.01*

*Table 2 Mental Readiness results – Comparison between Standard and Vanguard for Lead Surgeons and Scrub Practitioners*

| | **Lead Surgeons** | | **Scrub Practitioners** | |
|---|---|---|---|---|
| | Standard (n=66) M (SD) | Vanguard (n=7) M (SD) | Standard (n=84) M (SD) | Vanguard (n=13) M (SD) |
| Cognitive Anxiety | 3.36 (2.04) | 3.57 (2.64) | 3.90 (2.75)** | 6.69 (3.50)** |
| Somatic Anxiety | 3.76 (2.35) | 3.43 (2.51) | 3.93 (2.72)** | 6.54 (3.67)** |
| Confidence in self | 7.49 (2.68)* | 9.00 (1.15)* | 7.77 (2.49)* | 5.08 (3.25)* |
| Confidence in team | 7.80 (2.79) | 8.86 (1.21) | 7.90 (2.94)* | 5.62 (3.50)* |

*p< 0.05; ** p< 0.01

*Table 3 Challenges of Vanguard configuration mentioned by organ retrieval staff in open comments*

| Challenges of Vanguard configurations | N of participants who mentioned it |
|---|---|
| Pressure point | |
| ⇒ Cold phase | 5 (AB: LS=1, SA=1, SP=2; Observer =1) |
| ⇒ Cross clamp | 2 (AB: SP=2) |
| Practical challenges | |
| ⇒ Longer set up | 1 (AB: SP=1) |
| ⇒ Space constraints | 1 (CT: SP=1) |
| Procedural challenges | |
| ⇒ Equipment | 3 (CT: SP=1; AB: SP=2) |
| ⇒ Instrument count | 3 (AB: LS=1; SP=2) |

AB – Abdominal team; CT – Cardiothoracic team;
LS – Lead Surgeon; SA – Surgical Assistant; SP – Scrub Practitioner

*Table 4 Sources of Stress in Vanguard retrievals mentioned by organ retrieval staff in open comments*

| Sources of stress | N of participants who mentioned it |
|---|---|
| Communication | |
| ⇒ Different expectations | 5 (AB: SP=5) |
| ⇒ Pressure from surgeon | 3 (AB: SP=3) |
| ⇒ Pressure from SNOD | 1 (CT: SP=1) |
| Competing demands | |
| ⇒ Multitasking | 5 (AB: LS=1, SA=1, SP=3) |
| Other stressors | |
| ⇒ Difficult anatomy | 1 (AB: SP=1) |
| ⇒ Lengthy procedure | 1 (AB: SP=1) |
| ⇒ Noise | 1 (AB: SP=1) |
| ⇒ Personal circumstances | 3 (AB: SP=2; CT: SP=1) |

AB – Abdominal team; CT – Cardiothoracic team;
LS – Lead Surgeon; SA – Surgical Assistant; SP – Scrub Practitioner

*Table 5 Comparison between Lead Surgeon and Scrub Practitioner (excerpt)*

| | Lead Surgeon (n=74) M (SD) | Scrub Practitioner (n=98) M (SD) |
|---|---|---|
| Resource & Demand Evaluations | | |
| Perceived demands* | 3.16 (1.32) | 3.60 (1.52) |
| Perceived resources* | 4.32 (1.39) | 4.73 (1.14) |
| Mental Readiness | | |
| Cognitive anxiety* | 3.36 (2.07) | 4.28 (2.98) |
| SURG TLX | | |
| Mental demands* | 9.06 (5.52) | 11.60 (5.63) |
| Physical demands* | 9.00 (5.65) | 11.28 (5.89) |
| Temporal demands* | 8.20 (5.15) | 10.27 (5.95) |
| Task Complexity* | 9.23 (5.14) | 10.95 (5.64) |
| Situational Stress* | 7.88 (4.99) | 9.69 (5.74) |
| Distractions* | 7.10 (4.34) | 9.96 (6.33) |

*p< 0.05

## Figure Legends

*Figure 1 Data Administration Procedure*

*Figure 2 Mental readiness results for AB teams*

*Figure 3 Workload change score from Standard to Vanguard condition for Abdominal (AB) and Cardiothoracic (CT) teams*